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Meeting Report
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REPORT

of the

SIXTEENTH SESSION OF THE FAO/UNEP PANEL OF EXPERTS ON INTEGRATED PEST CONTROL

held in Rome, Italy
25-29 April 1994

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1994

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ABBREVIATIONS

CGIAR	Consultative Group on International Agricultural Research
CICP	Consortium for International Crop Protection
CIS	Commonwealth of Independent States
FAO	Food and Agriculture Organization of the United Nations
IPC	Integrated Pest Control
IPM	Integrated Pest Management
PASCON	Pan African *Striga* Control Research Network
RAFR	FAO Regional Office for Africa
RAPA	FAO Regional Office for Asia & the Pacific
RLAC	FAO Regional Office for Latin America & the Caribbean
RNEA	FAO Regional Office for the Near East
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

1. INTRODUCTION

The 16th Session of the FAO/UNEP Panel of Experts on Integrated Pest Control took place at FAO Headquarters, Rome, from 25 to 29 April 1994. The meeting was officially opened on behalf of the Director-General of FAO by Dr. H. de Haen, Assistant Director-General of the Agriculture Department. Dr. de Haen called the 16th Session of the Panel a landmark meeting for many reasons. Firstly, because now more than ever, FAO is called on to play a more decisive role in ensuring that the world will produce, in a sustainable way, enough to feed 9,000 million people by the year 2030. Most definitely, IPM will have a very important role to play in this endeavour to produce sufficient food without depleting global resources. Secondly, because the meeting took place when the Organization is studying its own restructuring in order to respond more quickly and more efficiently to the demands of Member Nations in their efforts to meet their food security goals. In the restructuring process, plant protection is receiving due priority and, as the chemical control paradigm has clearly shown its limitations and risks, IPM now more than ever will have to be incorporated into farmers' practices in order to guarantee sustainable production whilst preserving human health and the environment. Thirdly, IPM has now attracted the attention of the international community as the guiding principle in plant protection, capable of guaranteeing high yields whilst keeping costs reasonably low and minimizing the negative side-effects of agricultural activities in the environment. Therefore, Dr. de Haen welcomed the opportunity that Panel Members would have during the meeting of discussing with FAO, the World Bank, UNDP and UNEP, mechanisms for closer relationships in promoting IPM.

Dr. de Haen noted the increasing number of production systems, both in developed and in developing countries, where food and fibre production has been increased while the use of synthetic pesticides was reduced. He mentioned that many industrialized nations are now, for human health and environmental reasons, implementing effective programmes with well-set targets to reduce the overall use of pesticides. At the same time, developing countries worldwide are establishing legal and economic environments which have not only created a demand for more sustainable plant protection but also motivated industry to develop more effective, less toxic and more

environmentally-friendly pesticide formulations to fit into integrated pest management systems. Dr. de Haen reiterated the need for successful IPM programmes in developing countries to become the rule in plant protection and expressed FAO's administrative hope that a Panel, broadened by the co-participation of FAO, UNEP, UNDP and the World Bank, would be a first step in making IPM a reality everywhere. Since the international donor community has now fully accepted the IPM concept, Dr. de Haen foresees in the near future that they will match their enthusiasm for the approach with more generous contributions to make IPM work at the farm level in developing countries.

UNEP was represented by Dr. H.N.B. Gopalan, Programme Officer, who welcomed the participants on behalf of Ms. Elizabeth Dowdeswell, Under Secretary General and Executive Director of UNEP. He recalled that the 16th Session was meeting almost two years after UNCED, which recognized in Agenda 21, Chapter 14, IPM as a separate programme area. Dr. Gopalan complimented FAO and the Panel for bringing IPM to the forefront of international action for sustainable agriculture and rural development. He also stated that UNEP considers IPM the only available means to escape from the pesticide treadmill, as well as the only available route to low-input sustainable agriculture. He acknowledged the success of IPM but indicated that its universal application at the small-scale farm level is yet to be demonstrated. He reiterated the importance UNEP attaches to IPM and their satisfaction in working closely together with FAO to promote the practice of IPM further.

Dr. P.L. Adkisson, Chairman of the Panel, welcomed Panel members, invited speakers and FAO staff to the 16th Session and made a brief recapitulation of Panel activities since its inception in 1966. He, then, presented the Agenda to the Panel which was accepted and adopted (Appendix I). Main topics of the Panel were:Broadening of sponsorship of the Panel; Status and future of pesticides in IPM; Approaches for replacing chemical pesticides in IPM programmes; Current pest problems of special interest to the Panel; and new developments and needs for training in IPM. The Panel worked through working groups and closed sessions to deliberate on different topics of the agenda and develop its recommendations.

There was general satisfaction in relation to the way the meeting was structured and also in relation to what the Panel was able to accomplish. Future developments will dictate the *modus operandi* and constitution of a new Panel.

Definition of IPM

The Panel reviewed and reaffirmed the definition of integrated pest control (or integrated pest management) adopted at the first session in 1967. The Panel, however, felt the definition is somewhat dated and should be reviewed by future panels. The definition is:

> "For the purposes of this Panel, Integrated Control (lutte intégrée, lucha integrada, integrierte Bekampfung) is defined as a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below those causing economic injury." In its restricted sense, it refers to the management of single pest species on specific crops or in particular places. In a more general sense, it applies to the coordinated management of all pest populations in the agricultural or forest environment. It is not simply the juxtaposition or superimposition of two control techniques (such as chemical and biological controls) but the integration of all suitable management techniques with the natural regulating and limiting elements of the environment.
>
> The term "pests" includes animal pests (vertebrate and invertebrate), diseases and weeds.

History of UN Agency Partnership

In 1965, FAO convened a Symposium on Integrated Pest Control in Rome with a total participation of 87 scientists, representing 34 governments and seven international agencies. This Symposium recommended to the Director-General of FAO the establishment of a Panel of Experts. The Director-General accepted that recommendation and the FAO Panel of Experts on IPC was established in 1966. In 1979, it became a joint

FAO/UNEP Panel. Many activities were developed by FAO and UNEP to promote IPM in Member Nations as a result of the recommendations made by the Panel during its meetings. UNDP, through the funding of FAO IPM Projects, has also greatly contributed to the spread of the IPM approach worldwide. The willingness recently manifested by UNDP and the World Bank to join forces in sponsoring Panel activities to promote IPM further is very timely and will facilitate the establishment of a common agenda, involving FAO, UNEP, UNDP and the World Bank, to make IPM the rule in plant protection around the world.

Panel's role, vision and mission

The Panel reaffirmed its role, vision and mission as stated in the report of the Fifteenth Session, and indicated its readiness to continue to serve FAO, UNEP and the other future co-sponsors in promoting IPM research, development and implementation in developing countries. Whatever arrangements these agencies choose to enhance the promotion of IPM as the cornerstone of sustainable agriculture, the need for a panel of experts has been clearly perceived.

2. BROADENING SPONSORSHIP OF THE PANEL

During its Fifteenth Session, the Panel recommended that FAO should initiate action with other international development agencies (e.g. World Bank and UNDP), seeking their sponsorship of the FAO/UNEP Panel of Experts on IPM. The responses of these agencies to FAO's enquiries about their co-sponsoring the Panel have been very positive. UNEP also reassured its interest in continuing to co-sponsor the Panel with greater involvement and support.

Development of a UN-sponsored IPM Facility

In response to initiatives proposed by the FAO/UNEP Panel of Experts, efforts are now underway for four UN-related organizations (FAO, UNEP, UNDP and World Bank) to sponsor an IPM Facility. UN organization representatives have met to discuss mutual interests and develop the concept of the proposed Facility.

In response to requests from the IPM Facility Working Group, the Expert Panel has redrafted the proposed Terms of Reference for an advisory Panel of Experts on Integrated Pest Management to serve the IPM Facility. The Panel also formulated seven recommendations for the IPM Facility Working Group to consider in its further deliberations.

Recommendations on IPM Facility

The FAO/UNEP Panel of Experts on Integrated Pest Control Executive Committee met with selected FAO staff and UN related organizations' representatives to discuss a proposed four-organization IPM Facility that has been described in a draft report circulated to the Expert Panel membership. The Executive Committee's charge was to discuss and develop recommendations relative to the draft IPM Facility report for the full Panel of Experts' consideration.

Open discussion focused on the mechanics of the process of developing the IPM Facility and the expected timetable for activities. It was reported that the intent is to move forward with programme design through early June, leading to formal agency clearances later in 1994.

In view of the information discussed previously, and with responses to specific questions posed by members of the Expert Panel's Executive Committee, the following recommendations were subsequently adopted by the full Panel of Experts:

1. The Expert Panel is pleased to see action taken on the earlier panel recommendation to expand UN-related organization participation in IPM. The Expert Panel is encouraged by the stated intention of UNEP to continue involvement in the partnership, and by FAO's forging of partnerships through investments.

2. The Expert Panel recognizes that events have overtaken earlier recommendations regarding Panel membership, and recommends that a reassessment of future Panel make-up should address appropriate size, disciplines, geographic distributions, gender representation and staggered appointments for Panel continuity.

3. The Expert Panel, further recognizing the expanding responsibilities for future members, recommends that the frequency and selected attendance at meetings may need to be adjusted to better address commodity/discipline needs and serve advisory roles.

4. The Expert Panel recommends that the proposed IPM facility be constituted in the form of option 3 (the preferred option of the Task Force) to wit;

> **"Option 3:** A new facility, co-sponsored by the relevant UN agencies and the World Bank and hosted by one of the agencies. This may combine most of the advantages of the first two options, without including all the disadvantages. It would be flexible (if properly established), provide for fast responses, would have relatively low start-up costs and a short lead time, and could build on an established foundation. It could respond quickly to opportunities in the field and would benefit from already-existing project portfolios."

5. Moreover, the Expert Panel recommends that the Secretariat to the Panel become part of the IPM Facility. *[We assume that the Facility's sponsors will determine the administrative arrangements.]*

6. The Expert Panel recommends that the IPM Facility be sponsored by the four UN related organizations (FAO, UNEP, UNDP and World Bank) currently exploring the IPM Facility concept, and that other donors be included through advisory mechanisms, such as a "Donor's Council".

7. The Expert Panel further recommends that the sponsoring UN related organizations work out organizational issues to assure success of the IPM Facility. These issues include:

- Participation
- Mission and Purpose
- Structural Size, Shape, Linkages, Relationships
- Policy Guidance and Portfolio
- Advisory Panel and Governance

- Finance
  - Acquisition and Distribution of Resources
  - Evaluation of Merit
  - Coordination of Programmes with Mission and Purpose
  - Bilateral Conflicts (potential)
- Execution
  - Planning, Strategies, Priorities
  - Mechanisms for Decision-making
  - Establishment of Pilot Projects
  - Farmer-driven Approaches
  - Consensus-building and Buy-ins
- Implementation
  - Maintenance of Science Quality
  - Communication System(s)
  - Project Facilitation and Support
  - Oversight
- Accountability
  - Maintaining Science Quality
  - Auditing
  - Evaluation of Achievements and Success
  - Sunset Clause (i.e. time limit to the existence of the IPM Facility)

Draft terms of reference for an international panel of experts on IPM

1. Serve as an international advisory committee for the co-sponsors on the policy and programmes of the newly created IPM Facility on a global basis.

2. Serve as an international forum to develop and evaluate IPM policies and technical issues, especially those that simultaneously enhance sustainable crop production and environmental protection.

3. Serve as an intellectual and technical resource on IPM for the IPM Facility, for co-sponsors, donors and agencies in both developed and developing countries, and assist in developing institutional and/or national IPM policies and strategies.

4. Promote and encourage collaboration among national and international agencies, such as the CGIAR system, NGOs, universities and research institutes in the development and implementation of IPM projects, training programmes and technology transfer.

5. Identify opportunities for IPM based on technical and social criteria, where there is overdependence on pesticides and high current and potential environmental and health risk.

6. As requested, to consider strategies and specific implementation plans for IPM programmes at strategic locations.

7. Monitor and assess on-going IPM programmes and recommend improvements in these programmes.

8. Promote policies of governments and agencies which are conducive to sound IPM practices and seek removal of institutional constraints.

View of the Chairman, Dr. P.L. Adkisson

The Director-General of FAO established the Panel of Experts on Integrated Pest Control in 1966. The basis for establishing the Panel was FAO's need to have a group of experts to advise the Director-General on policy and programmes involving integrated pest control, to review principles and application of integrated control, promote joint research programmes and develop educational materials related to the integrated approach to crop protection. UNEP became a co-sponsor of the Panel in 1979 and the terms of reference of the Panel were expanded to place more emphasis on host plant resistance and use of non-polluting methods of controlling crop pests.

During the last meeting of the Panel in 1992, it reconsidered its mission and suggested it could best serve FAO/UNEP by:

1) providing FAO/UNEP with an intellectual resource for the promotion, development and implementation of IPM on a global basis;

2) serving as an international forum for developing and discussing IPM issues, and especially those that assure the sustainability of crop productivity, conserve biodiversity and promote environmental protection;

3) providing FAO/UNEP with a network of experts to facilitate collaboration, research, training, information exchange and technology transfer;

4) assisting and advising FAO/UNEP on policy issues and programme activities related to IPM; and

5) providing FAO and UNEP with other technical assistance as may be requested.

At its last meeting, the Panel recommended that FAO initiate action with other international development agencies (e.g. World Bank and UNDP) seeking their sponsorship of the Panel. It was also suggested that FAO seek greater involvement and support of panel activities from UNEP. The Panel recommended that, if sponsorship of the Panel is expanded, membership of the Panel be expanded by three new members representing environmental concerns.

This is the last meeting of the members of the current Panel as the terms of all members expire this year. Thus, this is a good time to make a transition to broadened sponsorship of the Panel and to increase the number of Panel members.

New sponsors have an opportunity to reconstitute the Panel, appointing all new members, or asking any members they wish to remain on the Panel to continue to serve. It is my recommendation that terms of future Panel members be staggered to ensured continuity.

The Inter-agency IPM Task Force proposed that a common agenda be established for IPM activities of all the sponsors and that an "IPM Facility" be established to implement this agenda. The Panel will be involved in discussions concerning

this matter and our recommendations will be a part of the Report of this Session. These recommendations will be developed for consideration by the full Panel by the Executive Committee of the Panel (Moscardi, Wang, Whitten, Zadoks and Adkisson. Dr. MacKenzie will serve as Rapporteur.

As stated in the draft report of the Inter-agency IPM Task Force, the terms of reference for the Panel will remain essentially the same as now. The Panel would serve the IPM facility by providing it with an intellectual resource in crop protection and production, technical assistance in identifying IPM targets of opportunity (e.g. "hot spots"), in developing and evaluation projects, developing educational materials, and providing a network of experts who may be called on as needed. If the concept being developed for an IPM Facility is approved and funded, the Panel will be called on more frequently for programme development and review, in work with *ad hoc* working groups on special topics, and by individual consultation with the various agencies and projects.

In conclusion, please allow me to add my endorsement to the concept that is being proposed and to pledge the support of the Panel of Experts on Integrated Pest Control in whatever role we are asked to play.

3. IDENTIFICATION OF IPM TARGETS AND OPPORTUNITIES

MacKenzie (Chairman), Zadoks, Frans, Adkisson, Forno, Wang, Waibel; Schulten (staff)

A Sub-panel was asked to identify a short list of IPM opportunities that could be considered for further study as potential pilot projects. The Sub-panel initiated the activity by identifying the considerations that should go in to a successful project design consideration. These topics were by categories: Opportunity for IPM implementation; Economic situation; Science and technology status; Government controls; Receptivity; and Existing networks. Each of these categories contained points to consider (e.g. Opportunity was made up of: Extent of pest crisis; Importance of the situation; Environmental interest; and Number of key pests). For each topic/subject a scale of 1-10 was constructed, and a survey

form was prepared for each of a long list of potential IPM opportunities, by nominated countries. The entire Panel was then asked to complete the survey form for as many potential IPM opportunities by country and to submit names of possible contacts for information follow-up.

Some concern was expressed by the Sub-panel members that other, potentially valuable opportunities might also deserve consideration. Consequently, the full Panel met to extend the list of opportunities under consideration and to develop by consensus a short list of opportunities for further evaluation.

Through the process, the Expert Panel proposed the following five IPM opportunities for implementation and noted the areas of strengths and deficiencies, based on information known to members of the Panel.

1. Cotton IPM in Asia

Pakistan - Three Panel members evaluated the vast opportunities for Cotton IPM in this country. All agreed that the pest crisis is severe and the importance is significant. Moreover, the number of pests to contend with is small.

The economic situation appears mixed for IPM. The incentives may be significant for change, the finances seem conducive and subsidies that would interfere are few to none. Price policies are, however, seen as an impediment.

The science and technology status for IPM On cotton in Pakistan seems extensive - almost "off the shelf". This is complemented by reasonably good supporting data. There may, however, be some existing technology gaps that will require research attention.

There appear to be few government regulatory controls that would interfere with IPM implementation and the receptivity for cotton IPM is, by most measures, quite positive. There is, however, no recognized "champion" for cotton IPM in the country.

There was substantial disagreement on the extent and effectiveness of existing networks in Pakistan that would

support IPM in cotton. Although the institutions are recognized as many and available, there appears to be less agreement on the readiness of Extension Systems and Training Programmes.

China (P.R.) - Respondents for Cotton IPM in China noted the severity and importance of the current cotton pest situation, the large extent of the environmental interest and the relatively few pests causing the crisis. In addition, key economic indicators suggest that the situation in China would be conducive to cotton IPM implementation (e.g. significant incentives, strong consumer interest, conducive finances, good price policies). There are, however, extensive government subsidies that could interfere with cotton IPM implementation, especially pesticide subsidies.

Much of the situation for science and technology is favourable, with concerns focusing on existing technology gaps and needed "up-stream" research to support cotton IPM implementation. However, much of the science and technology for cotton IPM in China could be considered "off-the-shelf".

Government controls are considered mostly acceptable, but not too much one way or the other.

The climate for overall receptivity was indicated as good to very good, as are the existing networks that might be used for cotton IPM implementation (institutions, extension system, training programmes). One respondent disputed the extent of training programmes, while another disputed the farmer-centred nature of existing networks, and these differences should be resolved by further study.

No Panel Member responded to the situation in India for Cotton IPM.

2. Vegetable IPM in Asia - The Panel made an evaluation for vegetable IPM in Thailand, China (P.R.), Viet Nam (2 respondents), Taiwan, the Philippines and India.

Taken across countries, there are many common points to be made. The extent of the pest crisis, the importance and the environmental interest are very similarly viewed. However, the

economic situations are substantially different or are unknown to the respondents.

In the area of science and technology for vegetable IPM in Asia, there appears to be significant amounts of existing, usable technology and useful models, while in other situations significant technology gaps may exist. Some projects on vegetable IPM would require "up-stream" research and the development of supporting data (e.g. pest maps).

Government controls are, for the most part, not strongly supportive of IPM implementation, and the receptivity for IPM, as viewed by the panel, varies widely. For instance, India, Taiwan and the Philippines were noted as potentially very receptive to vegetable IPM, while China and Thailand were perceived as problematic in areas such as: "lacking a champion"; government disinterest; no control over advertising (e.g. promoting pesticides); and organized opposition. Viet Nam received inconsistent scores for some aspects of receptivity, perhaps reflecting the rapidly changing agricultural policies of this nation.

Some of the networks useful to IPM implementation exist (or are accessible) for vegetable IMP in Asia, but these will need to be more completely monitored, as indicated by the respondents' scores.

3. Vegetable IPM in Africa - The Panel believes there is sufficient information available for country-specific opportunities for vegetable IPM in Africa. In general, the Panel viewed the opportunities as severe and important, with a large environmental interest, but unfortunately many pests (this creates difficulty for IPM implementation, which has a higher probability of success when the target pests are few).

The economic situation in several countries in Africa is conducive to vegetable IPM implementation, with excellent prospects in Kenya, Senegal and Mali.

Information obtained through Panel discussions was very incomplete for the status of science and technology for vegetable IPM in Africa. This indicates a strong need for study in this area, as the opportunity for vegetable IPM

implementation in Africa would be greatly enhanced by the availability of "off-the-shelf" technology and some successful models to use in project design.

There was strong agreement that government controls are at present not conducive to IPM implementation in most countries for which there were reports.

The potential for receptivity in most countries appears good for vegetable IPM, but the existence of networks useful for IPM implementation is almost uniformly inadequate or unavailable.

4. *Striga* IPM - The Panel noted the severity and importance of the *Striga* problem in Kenya, Gambia, Nigeria and Zimbabwe. (Note: The problem of *Striga* damage to crops is much more extensive in Africa and this list of countries should not reflect the more extensive distribution of this parasitic weed.)

Economic factors vary considerably according to country and government policies. Some governments are using counter-productive subsidies that could potentially interfere with IPM programme implementation, while other have potential conflicts with low consumer interests. In spite of these situations, there are said to be significant incentives for change to IPM.

The existing status of science and technology for *Striga* IPM is substantial, with no reported information technology or "up-stream" research needs for implementation. Government controls are judged to be acceptable in most countries and receptivity indicators are positive and substantial.

The existing implementation networks are all judged to be adequate to extensive or complete, with only minor exceptions (e.g. an apparent need to strengthen training programmes in Zimbabwe).

5. Cotton IPM in South America - Information on Cotton IPM in South America was brought to the attention of the Panel by members and observers who have experience with the cotton insect problem, and especially the spread of the boll weevil, in Brazil, Colombia and Paraguay. This is no doubt a

consequence of the very recent nature of the pest outbreak in this region and the rapidly changing circumstances and opportunities to deploy IPM strategies.

In general, the situation is an emergency crisis of major significance spreading to the major cotton production regions of Brazil, Paraguay and Argentina, with significant concerns for Colombia and elsewhere. The crisis is confined to just a few pests, and is primarily created by the cotton boll weevil.

Problems apparently exist with conflictory incentives and price policies that now work against IPM implementation. It was reported by pest management specialists from the region and from the USA that "off-the-shelf" technology is adequate for IPM deployment and technology gaps are not extensive for Brazil or Paraguay. Additionally, government controls that do not support IPM implementation could be easily fixed and existing networks are mostly adequate; especially for extension and training.

There is, moreover, a good situation for IPM receptivity in most areas for both Paraguay and Brazil. Concerns for receptivity mostly centred on government disinterestedness and organized opposition to cotton IPM implementation, which could be turned around with concerted efforts as part of a cotton IPM project in the region.

For four of the preceding five IPM opportunity areas (cotton in Asia, vegetables in Asia, vegetables in Africa and *Striga*), FAO has projects to address these needs in various stages of development. The Panel endorses these activities by FAO and encourages project development attention to the fifth opportunity (cotton in South America).

The Panel also identified a second set of IPM opportunities for future consideration. This set of topics was derived through the consensus process noted earlier. These items should receive consideration in future priority setting activities.

1. Soybean IPM in Southeast Asia
2. Vegetable IPM in South America

Finally, a list of other topics of continued IPM interest was:

1. Cereals in the Near East and Eastern Europe
2. Rice in China and the Democratic People's Republic of Korea
3. Rice in Latin America
4. Vegetables in Central America

The Panel wishes to note that the foregoing lists are not considered exhaustive, nor do they represent projects for which funding interest may be stimulated. In fact, for some projects IPM opportunities exist for scientific and technical reasons but lack implementation (a lack of financial sponsors).

In the process of identifying IPM opportunities, strong Panel interest was expressed in a project to increase IPM awareness. Although the Panel recognized that this activity would differ significantly from past investments in IPM, the opportunity to significantly improve IPM receptivity seems worthy of further study by FAO and UNEP.

4. SUB-PANEL REPORTS AND RECOMMENDATIONS

Sub-panel Report on Use of Pesticides in IPM

Members & participants: Terry, MacKenzie, Moscardi, Granada, Hardee, Toscano, Campanhola, Gopalan, Barbosa, Frans (Chairman)

The sub-panel reviewed and re-affirmed the definition of integrated pest control adopted at the first session of the Panel in 1967, and as reaffirmed in the report of the 15th session of the Panel (1992). Although the definition is somewhat dated and should be reviewed by future panels, it is clear that pesticides have been and remain an integral part of the IPM process. During the intervening years, from the inception of the work of the 1967 Panel to the present, rightful concerns have been expressed over the misuse and excessive use of pesticides, particularly as such uses threaten human health and environmental integrity. The present Panel

continues to urge the safe and intelligent use of pesticides when they are a part of the IPM programmes. Misuse or excessive pesticide use should not be tolerated in such programmes.

In view of these considerations, the sub-panel recommends the following:

1 That access to the latest information available on IPM programmes, pesticide use, and safe pesticide application be continually upgraded and improved. Particular note should be made of the new international IPM electronic data base and communication facility, "IPMnet", now available to those having access to computer network (Internet) facilities. For those not having access to a network, the possibility should be explored of providing pertinent information requested on diskette. Other electronic data base use should be encouraged, such as those available on CD ROM, including CABPESTCD (UK) and Pest Bank (Silver Platter, USA).

2 That FAO continue to promote and provide suitable training, where appropriate and possible, on proper use of pesticides in IPM programmes recommended for implementation and in which pesticides are an integral part of the overall IPM strategy; and further it should provide literature or other data base information to participants in these programmes in order to educate them on proper procedures regarding the safe and judicious use of pesticides.

3 That development of pest strains' resistance to pesticides be recognized as a recurring world-wide problem where long-term pesticide use has been practised and to provide early warning capabilities for detection of pesticide-resistant pest strains and for forecasting pest outbreaks. Pesticide-resistant pests have become a problem in many species of insects, fungi and weeds, reducing true effectiveness of chemical control whenever it is required.

4 That FAO/UNEP continue to encourage countries participating in sponsored projects to be aware of the FAO International Code of Conduct on Distribution and Use of

Pesticides, covering sale, distribution, and use of pesticides, including the amended Prior Informed Consent clause covering movement of chemicals, including pesticides, in international trade. Both of these instruments are recommended to those creating the new IPM Facility, for consideration in their chartering procedures and inclusion as part of their agreements among participating nations. It is realized that implementation of the Code of Conduct at the national level is very difficult, but the mechanism is available for implementation and ultimately should become legally binding. In future IPM programmes it may be necessary to link funding to the acceptance and implementation of these agreements by participating countries.

Sub-panel report on pesticide policies

Members: Zadoks (Chairman), Dinham, Granada, Smetnik, Waibel

Recognizing the importance of agricultural policies in general and pesticide policies in particular, the FAO/UNEP Panel of Experts on IPM formed an *ad hoc* Working Group on Pesticide Subsidies during the 1992 Panel meeting. The Working Group held a joint meeting in Rome in April 1992 with a representative of the World Bank Agricultural Policy Division. It was decided that, in order to obtain better information on these issues, the following three studies should be undertaken:

1. a study of donor policies with regard to pesticides and IPM, commissioned by the University of Göttingen (G. Fleischer);

2. a study of the role of NGOs in IPM, commissioned by PAN (Sarojeni Rengam);

3. a study on pesticide policies in developing, commissioned by the World Bank (J. Farah).

The Working Group further decided to organize and conduct a workshop with economists from developing countries in order to develop and agree on a conceptual framework for conducting country studies on pesticide policy. This workshop was held

in Göttingen during the of 28 February to 4 March 1994 under the sponsorship of FAO. The papers developed during the workshop will be published by the University of Göttingen and the working papers will be circulated separately.

Recommendations of the Sub-panel

1. Recognizing the need for more evidence and quantitative information on the impact of pesticide policies, it is recommended that FAO cooperate with the World Bank in providing funding for conducting country case studies on pesticide policy.

2. In order to have a critical number of case studies, at least 12 countries should be selected with equal distribution among Africa, Asia and Latin America. For the present, Europe and the republics of the former USSR will not be included. The Panel recognized that the Germany Agency for Technical Cooperation (GTZ) has provided support for four country studies. Preferably the country studies should be carried out by local research/ development institutions involving social and natural scientists.

3. More effective collaboration should be encouraged between social and natural scientists. A network of regional economists/social scientists should be established in order to maintain a constant dialogue with policy-makers and administrators to provide information and advice on pesticide policies.

4. Recognizing the urgent need for a better information base, it is recommended that the future IPM Facility explore the possibility of establishing a database on pesticide use by country, crop, type of pesticide (quantity and value) over an extended period of time.

5. It is recommended that, as a first step, the conceptual framework which was developed during the working in Göttingen be adopted for conducting future pesticide policy studies.

Comment and Recommendation by Sub-panel on Alternative Options for Reducing Dependency on Pesticides

Members: Whitten (Chairman), Shad, Wang, MacKenzie, Deaton, Thiam

The Panel recognizes the urgent need to develop and make available a range of options for pest[1] management that are economically sound, sustainable and environmentally friendly. To this end, the Panel believes it is essential that non-chemical pest management options should be developed that will reduce dependency on chemical pesticides, and that these options should become available to the world's farmers responsible for agricultural production.

The Panel recognizes that a wide range of options for pest management already exist or are being developed. These include:

1. biological control, including (1) conservation of the local biodiversity and its optimal utilization for pest suppression, (2) classical biological control with exotic natural enemies and (3) innundative release of natural enemies.

2. biological pesticides, where the biocontrol agent could be: a fungus whose target is an arthropod pest, a weed (e.g. mycoherbicides) and/or a plant pathogen; an insect-killing nematode; a bacterium; or a virus or other micro-organism such as a protozoan or microsporidian.

3. host plant resistance, including the exploitation of naturally occurring genetic variation in the host; or by using biotechnology and genetic engineering to develop diagnostics and create novel genotypes that create resistance or tolerance to a disease or pest.

4. autocidal methods, such as the sterile insect technique.

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[1] including vertebrate and invertebrate pests, weeds and pathogens

5. a range of physical (e.g. pest exclusion, controlled atmospheres, and temperature extremes) and cultural (e.g. soil handling, phytosanitary practices, crop rotations, mixed crops, etc.) methods.

6. novel chemicals, e.g. pheromones, kairomones and growth regulators, that affect development or behaviour.

However, there are many major pests, weeds and diseases where these non-chemical alternatives are not available in practice either because critical base-information does not exist for the pest, or because adapting this information to local circumstances remains to be done.

Because of the above considerations, the Panel makes the following recommendations:

1. That FAO/UNEP continue to be an effective champion and leader of global IPM policy and practice for economic and environmentally sustainable agricultural production.

2. That FAO/UNEP encourage member countries to espouse commitment to IPM as agreed during the UNCED Conference in Rio de Janeiro and that this commitment be reflected in public policy and manifest itself in practical support for the adoption of IPM practices.

3. That FAO/UNEP recommend that member countries ensure that providers and users of chemical products pay the full costs of pesticides. This would recognise the environmental and social externalities which favour chemical pesticides through the existence of direct or indirect subsidies; especially where these discourage adoption of those non-chemical alternatives which are otherwise economical and environmentally sustainable.

4. That FAO/UNEP encourage member countries to support bench mark research and development aimed at providing knowledge on pests and factors which influence their pestiferous status in local

environments. Whereas understanding of the cause(s) of a pest problem should be the pre-requisite for the selection of optimal control strategies and formulation of site-specific programmes, up-stream and farm level research on the ecological and socio-economic aspects of the pest problem should be encouraged, especially those aimed at revealing the inter-relationship among the pest(s), the natural enemies, the host plants and the cropping/eco-system.

5. That FAO/UNEP encourage member countries to support strategic/tactical research aimed at developing non-chemical options or adapting existing technologies to local circumstances so that IPM opportunities become widely available.

6. That FAO recognize the urgent need to support extension and training programmes so that farmers are empowered to become experts at managing pests.

7. That FAO/UNEP organize training of scientists, especially in developing countries, as they learn about the development of alternative control technologies from those who have already advanced in this field.

8. That FAO/UNEP assist in the development of packages of IPM-based technologies for different crops/areas to be prepared in support of training programmes for farmers and extension workers. FAO should support the organization and conducting of these training programmes.

Sub-panel on New Developments and Needs in Training for IPM

Members: Escalada (Chairman), Davidson, Terry, Moscardi, Dinham

Participatory approaches for training field-level workers and farmers have had significant impact on pest management decision-making and practice. These methods promote farmers' ability to gather, analyze and interpret information to make informed decisions and link researchers with farmers. As an interface mechanism between research and implementation, participatory methods can bring about a better perception of pest management problems, identification of knowledge gaps, design of relevant problem-driven research and development of simplified crop protection technology.

Recommendations of the Sub-panel

It is recommended that:

1. FAO/UNEP recognize the need to support extension and training programmes so that farmers are empowered to become experts at managing insect pests, diseases and weeds. Whenever appropriate, FAO should promote the use of participatory training in different countries with location-specific pest problems. Whenever possible, the involvement of NGOs should be encouraged because of their experience in the use of alternative training approaches. In the implementation of future IPM projects, FAO should ensure that appropriate structures are in place to provide men and women farmers with greater access to IPM information. Greater attention should also be directed to the development and application of mechanisms that will reinforce training efforts in order to minimize loss of information.

2. In IPM training programmes for farmers, FAO/UNEP should encourage the development and utilization of support mechanisms that accelerate farmer-to-farmer diffusion of IPM information, effectively bring about increased

awareness and changes in farmers' perceptions and facilitate training programmes.

3. FAO should initiate a review of the training components of projects on IPM implementation and sustainable and low-input agriculture in various regions to assess needs and document successful methodologies which may be adapted by future IPM training programmes, as appropriate.

4. Policy-makers have an important role to play in promoting IPM but are often not qualified to make valid judgements and informed decisions about this protection strategy. It is recommended that FAO use its resources to inform policy-makers of the opportunities for exploiting IPM. This could be implemented by:

   a. taking policy-makers to sites where IPM has been successfully implemented;

   b. providing information on the technology, costs and benefits of IPM, together with a balanced view of its potential.

   c. updating the FAO booklet, "Integrated Pest Control - what it means; why it is urgently needed; what is to be done; who should do it", published in 1971 at the initiative of the Panel and "directed towards agricultural administrators and planners". Other publications on IPM could be updated subsequently.

5. RECOMMENDATIONS FOR PANEL'S FUTURE PROGRAMME OF WORK

Sub-panel on Programme of Work for the Panel

Members: Zadoks (Chairman), Adkisson, Moscardi, Wang, Whitten; Staff: Barbosa

Preamble to recommendations

The Panel recognizes that this is the last session of the membership of the Panel as it is currently constituted and that a new Panel will be formed for the next session. In order for

the next Panel to benefit from our experiences, and to provide continuity for several on-going activities, the following suggestions are presented for the future programme of work.

The Panel is pleased with the progress that is being made in negotiations between FAO/UNEP, UNDP and World Bank, in broadening the sponsorship of the Panel and endorses the recommendations proposed by the Inter-Agency IPM Task Force to establish an IPM Facility jointly sponsored by the above organizations. If these recommendations are accepted and implemented, the Panel suggests that consideration be given to inviting a few members of the present Panel to serve as a transition team to assist in the formation of the new advisory Panel on Integrated Pest Management and to advise on other matters as requested.

The Panel recognizes with appreciation the progress made by FAO/UNEP in implementing the Panel's recommendations of 1992 (Appendix III), and is especially pleased about the successful Global IPM Meeting in Bangkok, 1993.

1. IPM Project evaluation

The Panel, considering the need of an adequate financial evaluation of IPM project *ex ante* and *ex post*, and having taken notice of the draft reports on such evaluation, recommends:

that these reports be further improved and updated, their interface be defined, a multicriteria matrix for external effects be developed, and the weights of the criteria be made explicit. The Panel further recommends that the future IPM Facility seek funds to test the methodology presented in these reports.

2. Continuity of IPM projects

The Panel recognizes that there have been instances in the past where, although a formal IPM project has demonstrated success in controlling the pest complex of a crop, farmers have not continued use of IPM after the project has been terminated but have reverted to previous practices, or have implemented new practices that are highly dependent on pesticides. The

Panel believes that a lack of continuity in a few projects can have an adverse effect on the credibility of IPM in future projects and recommends that:

an *ad hoc* working group of the Panel be convened to identify and analyze the factors which contribute to the decision by farmers to discontinue an IPM programme so that we may know how to better ensure the long-term continuity of IPM programmes. Available documents (published and unpublished) should be analyzed and farmers and other persons who have implemented IPM systems for selected crops which have later been discontinued should be interviewed. Factors need to be identified which can be used to strengthen and better assure continuation of IPM by farmers after formal projects have been terminated. Knowledge of these factors may then be used in the development of future IPM projects.

3. Balance in IPM approaches

The Panel, considering that IPM is usually developed for a particular crop (or group of crops) and the cropping systems associated therewith, emphasizing that due attention must be given to the fact that some approaches to the control of each pest may differ conceptually and in time scale, and recognizing that neglect of one pest component may adversely affect the success of the overall IPM system, recommends:

that, in the Panel's deliberations and for IPM projects developed in the future, a careful balance be maintained among the various pest components of the targeted cropping systems.

4. Cottage industry of biological pest control

The Panel, considering that in some developing countries good opportunities seem to exist for non-industrialized methods of biological pest control, recommends:

that a mechanism be developed for international interaction on and international transfer of non-industrialized production methods of biological pest control agents, and that disincentives to such production methods be removed.

5. Code of Conduct

The Panel, considering that the FAO International Code of Conduct on the Distribution and Use of Pesticides will be have been in effect for ten years at the 1995 FAO Conference, recommends:

that the Code of Conduct be re-examined to determine if the IPM component therein might be strengthened.

6. IPMnet

The Panel, appreciating the importance of electronic communication systems and especially of the newly established IPMNET, recommends:

that the future IPM Facility consider co-sponsorship of IPMnet with the Consortium for International Crop Protection (CICP) and the United States Department of Agriculture (USDA) and provide better support to developing countries so that thy can access and contribute to IPMnet and other electronic communication systems.

New Biotechnology

The Panel, considering that IPM has many components and may apply technologies developed by many different disciplines, acknowledges that biotechnology may make significant contributions to IPM by reducing the dependence on environmentally-harmful pesticides, and recommends:

that the possible contributions of biotechnology in improving current pest control methods be explored. These ares may include the use of: quantitative trait loci probes for the rapid incorporation of multigenic host plant resistance into improved cultivars; genetically-fortified biological control agents; and enhanced diagnostic tools for identification of pest variants in IPM programmes.

APPENDICES

- I Agenda of the 16th Session
- II Panel Membership
- III Panel Recommendations of 15th Session (1992)
- IV Summary of Working Papers

APPENDIX I

Meeting of the

16th Session of the FAO/UNEP Panel of Experts
on Integrated Pest Control
25-29 April, 1994
FAO, Rome, Italy
Lebanon Room, D-209

AGENDA

Monday, 25 April

Morning Session

8:00 - 9:00 Registration

Opening of the Meeting

9:00 - 9:30 Welcome address by Dr. H. de Haen, on behalf of FAO, by Dr. H. Gopalan on behalf of UNEP and by the Chairman of the Panel

9:30 - 10:00 Introduction of Panel members, Invited Speakers, FAO Staff and Observers. Adoption of the Agenda

Broadening the Sponsorship of the Panel

10:30 - 11:00 View of FAO
N.A. Van der Graaff, Chief of the Plant Protection Service

11:00 - 11:30 View of UNEP
H. Gopalan, UNEP

11:30 - 12:00 View of the Panel
P.L. Adkisson, Chairman of the IPC Panel

Afternoon Session

13:30 - 14.30 View of UNDP
N. Brady

14:00 - 14:30 View of the World Bank
Douglas Forno

14:30 - 15:00 Discussion

15:30 - 17:30 FAO Administration, UNEP, UNDP and World Bank Representatives to meet with Panel Executive Committee to discuss future sponsorship and activities of the Panel and agree on a memorandum of understanding (Free time for other delegates).

Tuesday, 26 April

Morning Session

08:30 - 10:00 Recommendations related to the sponsorship of the Panel

Status and Future of Pesticides in IPM

10:30 - 11:30 New opportunities ("Pest Hot Spots") which individual Panel Members may wish to report to Panel (five minutes per report). Written reports to be submitted to Panel Secretariat (S. Barbosa) prior to the meeting (1-2 pages).

11:30 - 12:00 Discussion

Afternoon Session

13:30 - 13:45 Role of Insecticides in IPM (P.L. Adkisson)

13:45 - 14:00 Role of Herbicides in IPM (P.J. Terry)

14:00 - 14:15 Role of Fungicides and Nematicides in IPM (J.C. Zadoks)

14:15 - 14.30 Use of Pesticides in IPM as related to Agenda 21 of UNCED (P.E. Kenmore)

14:30 - 15.00 Global markets and Future Prospects for Pesticides (H. Waibel)

15:30 - 16:00 Discussion

16:15 - 17:00 Special Topic: Status of Pesticide Resistance and Its Management (R. Frans with discussion of F.W. Plapp's working paper by P.L. Adkisson)

17:00 - 17:30 Discussion

Wednesday, 27 April

Morning Session

Approaches for Replacing Chemical Pesticides in IPM Programmes

8:30 - 9:15 Transgenic Plants in IPM (R. Deaton)

9:15 - 9:30 Discussion

9:30 - 10:15 Biological Pesticides and Genetically Engineered Micro-organisms in IPM Programmes (M. Whitten, F. Moscardi and G. Granada)

10:15 - 10:30 Discussion

11:00 - 11:45 Use of Novel Chemicals (Pheromones, Growth Regulators etc.) in IPM Programmes (D. Hardee)

11:45 - 12:00 Discussion

Afternoon Session

Pesticide Subsidies

13:30 - 14:30 Impact of Pesticide Subsidies on the Rate of Implementation of IPM by Farmers (H. Waibel, J.C. Zadoks and G. Feder)

14:30 - 15:00 Discussion on pesticide subsidies

15:30 - 17:30 General discussion on the pesticide issue and formulation of short and long-term strategies in relation to the use of pesticides in IPM programmes (formation of sub-working groups, studies to be conducted, etc.)

Thursday, 28 April

Morning Session

Current Pest Problems of Special Interest to the Panel

8:30 - 9:00 Boll Weevil in South America (C. Campanhola)

9.00 - 9.30 Whitefly in the Near East (G.G.M. Schulten)

9:30 - 10:00 Whitefly in the USA (T. Henneberry)

10:30 - 11:00 Aquatic Weed Management (T. Center) (absent)

11:00 - 12:00 Discussion

New Developments and Needs for Training in IPM

12:00 - 12:30 Report of the Working Group on Participatory Training (M.M. Escalada and C.A.J. Putter)

Afternoon Session

Update from the 15th Session Meeting

13:30 - 13:45 Report on the IPM World Conference in Bangkok (P.E. Kenmore) (absent)

13:45 - 14:00 Discussion

14:00 - 17:00 Executive Closed Panel Session to:

- review Working Papers
- consider Reports
- prepare Panel Session Report

Friday, 29 April

Morning Session

Executive Closed Panel Session continues to:

8:30 - 12:30
- complete Report
- decide on future Programme of Work
- finalize Recommendations to FAO/UNEP

Afternoon Session

13:30 - 14:30 Closing Panel Session Meeting

APPENDIX II

16th Session of the FAO/UNEP Panel of Experts on Integrated Pest Control

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APPENDIX III

Action taken on Panel Recommendations of the 15th Session (1992)

Recommendations and action taken

a) *FAO should initiate action with other international development agencies (e.g. World Bank and UNDP), seeking their sponsorship of the FAO/UNEP Panel of Experts on IPC, and it also should seek greater involvement and support on the part of UNEP;*

Discussions are ongoing and were reported at the 16th Panel Meeting.

b) *If sponsorship of the Panel is expanded to include other UN development agencies, the membership of the Panel should then be increased by three (3) new members representing environmental concerns;*

This will be discussed once final agreement on sponsorship has been reached.

c) *FAO should designate IPM as a Special Action Programme to emphasize accomplishments of past and present FAO IPM programmes and to focus greater attention on IPM as the best option for a system of crop protection that sustains crop productivity, conserves bio-diversity and protects the quality of the environment;*

IPM is one of the Special Action Programmes that were approved by the 1993 FAO Conference.

d) *As new IPM programmes are developed and implemented by FAO, attention should be given to increasing Head quarters' staff and resources so that each project is adequately managed and backstopped;*

This recommendation will be considered when FAO's reorganization plans are known.

e) *In the development of future FAO IPM projects, greater attention should be given to the control of all pests (weeds, insects, pathogens, nematodes, etc.) of the target crop(s);*

Due attention to pests besides insects will be given where relevant, e.g. vegetable projects, fruit projects, etc.

f) *FAO should seek means to expand the rice IPM programme in S.E. Asia to other countries and regions of the world;*

New countries in the rice IPM programme are Cambodia and Laos. Bhutan, Nepal, Myanmar, Pakistan and South Korea have observer status.

g) *FAO should initiate IPM projects on vegetables, fruit and cotton as soon as funding becomes available;*

The following projects were formulated and funding has been sought;

- Inter-country Programme for the Development and Application of IPM in Cotton in Asia (5 years; 10 million US$);

- Protected Cultivation in the Near East;

- FAO Inter-country Programme for the Development and Application of IPM in Vegetable-growing in South East Asia (5 years; 7 million US$);

Ongoing - GCP/SUD/025/NET, Phase 4. IPM In vegetables, wheat and cotton (3 years; 3 million US$);

Terminated or ongoing or in preparation, various small TCPs: TCP/ECU/2353 (tomato); TCP/RLA/2261 (boll weevil); TCP/PAK/2357 (cotton); TCP/DRK/2355 (rice); TCP/RAB/4451 (whitefly); TCP/RAF/... (rice);

In preparation - Integrated Vegetable Production and Protection in Africa (3 years, 3 million US$).

h) *FAO should consider new IPM projects for soybeans in Latin America, cereals in the Near East, and for several aquatic and terrestrial weeds in Africa and the Near East;*

In preparation - Regional project Sunn pest, Near East; Citrus IPM, Near East; Olives IPM, Near East;

Ongoing -

RAB/88/025 (virus disease of fruit crops)
GCP/GHA/026/EEC (aquatic weeds)

Terminated, ongoing or in preparation, TCP projects:

TCP/RAF/2253 (*Orobanche*; *Cuscuta*)
TCP/RAF/2263 (*Striga*)
TCP/EGY/2358 (water hyacinth)
TCP/BOL/2255 (water hyacinth)
TCP/CUB/2355 (aquatic weeds)

i) *FAO should continue compiling, publishing and disseminating information to promote awareness of IPM, its principles and the techniques required for its practical application. These materials should be designed for use by various audiences, e.g. farmers, plant protection specialists, research scientists and policy-makers;*

Terminal report IPM projects; Reports, brochures IPM projects; Global IPM meeting brochure and report; Articles *Plant Protection Bulletin*.

j) *Informational networks for IPM (e.g. Pan African Striga Control Network [PASCON], etc.) should be encouraged, supported and expanded as resources permit. IPM workshops and conferences should be conducted as appropriate;*

PASCON is supported through Regular Programme IPM workshops financed through RP in 1994: Cotton IPM in Africa; Date palm IPM Near East.

k) *Men and women farmers should be encouraged to participate in IPM training sessions where they can learn how to use IPM tactics for their own crops. Greater attention should be directed towards increasing participation by women in IPM research, development and training programmes. Also, action should be taken to encourage more women farmers to participate in IPM training sessions;*

Where appropriate, a special paragraph is included in project documents to emphasize women's participation and ways to achieve this.

l) *FAO should recognize the great advances made in the methodology for participatory training of field level IPM workers and farmers by the S.E. Asia rice IPM programme. This methodology leads farmers to become better and more responsive partners for researchers and provides a greater feedback mechanism from farmer to researcher to farmer. This methodology should be formalized and used in the implementation of other IPM programmes as appropriate;*

A working group on this topic is functioning and documentation being provided.

m) *Economic (cost/benefit) analyses should be incorporated into all FAO plant protection projects, including plant protection components of other agricultural and agriculturally-related (e.g. aquaculture) projects;*

Guidelines for economic analysis are being prepared.

n) *FAO should review the current status of the economic analysis of major plant protection projects of other important development agencies, encouraging them to incorporate cost/benefit analyses into their plant protection activities;*

Guidelines for economic analysis are being prepared.

o) *FAO should develop and initiate training programmes in developing countries on the methodology for making economic analyses of IPM programmes; and should establish a network of IPM economists as members of national IPM teams;*

Guidelines for economic analysis are being prepared.

p) *FAO should initiate an effort to improve informational bases concerning pesticide use on a worldwide basis. In particular, industry data should be made available on the annual use of pesticides on a per crop basis;*

This information can be bought on the open market. Costs are considered to be too high. Some data-collecting is done for FAO Statistical Yearbook

q) *FAO should conduct a review of existing pesticide policies and the implementation of the FAO Code of Conduct in countries where IPM projects are in place or being planned;*

Reports on this topic have been prepared and distributed to Panel members.

r) *The Panel should establish a working group before the next session to: (1) discuss more fully the issues involved in the economic analysis of IPM projects; (2) develop recommendations concerning these issues; and (3) suggest guidelines for incorporating economic analyses into IPM programmes;*

This working group is functional and guidelines are being prepared.

s) *The Panel should establish a working group before the next Session to identify key issues involved in pesticide assistance agreements and pesticide subsidies and to ascertain how they affect the implementation of IPM. This working group should prepare a discussion of these issues, with pertinent recommendations, to be presented at the next Session of the Panel;*

This working group is functions; reports have been prepared and are being discussed.

t) *FAO should explore ways and means of establishing collaborative activities with members of the Commonwealth of Independent States (CIS) involving crop protection, pesticide pollution-prevention, conservation of biodiversity and the protection of important germplasm resources. It is recognized that this collaboration might require new approaches by FAO, but the Panel suggests the benefits to be gained would be worth the significant efforts involved:*

A study will be prepared with Netherlands funds on cotton production/protection around Lake Aral. Depending on the results, project activities will be developed.

APPENDIX IV

Summary of Working Papers

- Role of Insecticides in IPM (Adkisson)
- Role of Herbicides in IPM (Terry)
- Role of Fungicides in IPM (Zadoks)
- Global Markets and Future Prospects for Pesticides (Waibel)
- Status of Pesticide Resistance and its Management (Frans and Plapp)
- Transgenic Plants in IPM (Deaton)
- Biological Pesticides and Genetically-engineered Micro-organisms in IPM Programmes (Whitten, Moscardi and Granada)
- Use of Novel Chemicals in IPM Programmes (Hardee)
- Boll weevil in South America (Campanhola)
- Whitefly in the Near East (Schulten)
- Whitefly in the USA (Henneberry)

THE ROLE OF INSECTICIDES IN INTEGRATED PEST MANAGEMENT

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Summary

If world food production is to be increased it is essential that harmful crop pests be controlled. Chemicals presently provide a reliable immediate solution for controlling crop pests and this is the reason they are used in such large quantities. Chemicals will continue to be needed to control certain pests. However, we must learn to use them strategically, in minimum quantities, and with minimal hazard to people, other non-target organisms and the overall environment. Over the long term, we must develop and implement integrated, ecologically sustainable technologies for pest control that will provide better protection for crops and less danger to human health and the environment than methods which depend on the intensive use of chemical pesticides.

Insecticides are the most powerful weapons available for controlling most pest outbreaks. As such, they should be used strategically and carefully to maximize their advantages and minimize their limitations. When used correctly, insecticides provide an effective means for controlling insect outbreaks quickly and economically.

Because insecticides are the ultimate weapon in the war against crop insect pests, they can cause great damage not only to the pests but also to the pests' natural enemies. Everything possible should be done to preserve indigenous natural enemies, allowing them to increase and exercise the greatest amount of natural biological control of the pests as possible. The unilateral use of chemical insecticides without regard to indigenous natural enemies is a costly and self-defeating strategy which should be avoided at every opportunity.

Now, and in the future, more attention must be given to the selection of the best insecticides to use for the control of specific pests and how these chemicals may be best used in an IPM system. The use of insecticides should be integrated with other control measures to gain the desired level of pest suppression with minimal damage to arthropod natural enemies and other components of the environment.

The basis of IPM is the use of selective measures to hold pest numbers below crop-damaging levels in an environmentally-friendly and sustainable way. There are many ways that insecticides may be used with more selectivity. Among these are the following: (1) use of precision application methods which target the pest but not its natural enemies (e.g. seed treatments, systemics, directed sprays); (2) use of baits and bait sprays; (3) treating at a strategic time in the insect pest's seasonal cycle when great reductions in pest numbers may be obtained without serious damage to its natural enemies: and (4) use of reduced dosages of insecticides or the selection of less toxic compounds for reducing pest numbers while maintaining natural enemies.

Insecticides should be used only when necessary and in a way that causes he least damage to indigenous natural enemies. This is a basic principle which should always be remembered in developing and using IPM for the control of arthropod pests of crops.

THE ROLE OF HERBICIDES IN INTEGRATED PEST MANAGEMENT

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Summary

Weed management, of necessity, has to be integrated with other agronomic components of crop production. Herbicides, therefore, must be similarly integrated if they are to be used safely and effectively.

Developed countries are the main users of herbicides and are unlikely to lose their dependency on these pesticides. Herbicides have the potential to solve many weed problems in developing countries but are often not used for a variety of factors including availability of labour,cost, lack of information, etc. It is predicted that herbicides will find increasing utility in developing countries and that they, too, will develop a dependency on these products.

Options for reducing herbicide inputs are summarized. They include reduced doses, band treatments, additives to improve performance and more effective application methods. Alternatives to the use of herbicides are also provided, including cultivations, mulches, physical energy, biological control, natural chemicals and cultural weed control.

Examples are given of where the presence of weeds can have positive and negative effects on the presence of other pests, thereby complicating IPM strategies for controlling weeds and these pests at the same time.

It is concluded that the concept of reducing herbicide inputs as part of an IPM strategy is compatible with the need to integrate inexpensive herbicide technology into traditional farming systems.

THE ROLE OF FUNGICIDES IN INTEGRATED PEST MANAGEMENT

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Summary

Development of fungicides went from classical preventive chemicals to modern curative chemicals. The classics were sulphur and ionic copper, applied to the foliage to prevent germination of fungus spores and subsequent penetration of the foliage by the fungus. From 1957 onwards systemic fungicides were developed which, when sprayed onto the plants, enter them. Systemic fungicides control pathogenic fungi by fungicidal or fungistatic action, even when the fungi have already entered the plant. Thus, systemics act as eradicants.

Technical advance is great, from kilograms per ha of the old protectants to grams per ha of new eradicants. From the environmental point of view, the relatively narrow action spectrum of systemics is an advantage. As far as is known, systemics do not affect mycorrhizal fungi. Most of them are not down-transported to the roots. Registration tests should check that they do not kill entomophagous fungi, such *Entomophthora*, *Metarhizium*, *Verticillium lecanii*, and so on.

The next step of technical advance is being made nowadays, reducing dosages per ha once more by a factor 10 to 100. Seed treatment with systemic fungicides, either directly or indirectly by seed coating, can be highly effective, giving the emerging seedling and the young plant a protection for two to six weeks.

Dosages prescribed by labels on packages are meant to guarantee a good result of treatment after correct application of the fungicide. In several cases, the same or at least an adequate result can be obtained by a lower dosage, down to 10% of the recommended dosage. Successful low dosage treatment requires great knowledge and know-how of the farmer, who must see to it that crop and weather are just right. Even so, he is at a great risk of failure. The logical consequence of low dosage treatment may be frequent treatment, leading to limited environmental advantage at best.

Biologicals. A new group of fungicides is formed by the biologicals. Among them are fungi and bacteria. Fungivorous fungi are frequent in nature, especially in the autumn when both temperature and humidity are relatively high. *Trichoderma* spp. are used in soil treatment against damping- off of seedlings. *Verticillium lecanii* and other fungi are tested in foliar sprays, e.g. against cucumber mildew. *Verticillium biguttatum* applied to potatoes after reaping in the green harvest procedure protects potatoes against black scurf, *Rhizoctonia solani*.

Bacteria are used in foliar sprays, usually not with convincing success. More interesting are the fluorescent Pseudomonads which form siderophores. Siderophores are iron chelating compounds. Most micro-

organisms need iron from the environment as a micro-nutrient. When the iron is captured by bacterial siderophores it is no longer available to the pathogen, which then cannot infect a plant. Bacterization of seed and planting material is being studied now.

Though such bacteria are not fungicides in the classical sense, they may be marketable just like fungicides. The same may be true of fungi mimicking the pathogenic fungi in their niche preference. Several non-pathogenic strains of *Fusarium oxysporum* applied timely and/or at high dosage to seed or planting material may prevent the plants from being infected by the pathogenic strains of the same species. In all such cases the mechanisms of action may be far more complicated than suggested here, or even than known. Effective large-scale applications are scarce, but technical progress is being made.

Non-pesticides. Several products show resistance- inducing or resistance-improving effects. Among these are salicylic acid, INA and *Polygonum* extracts. The latter are being marketed now. I believe that formulation, a secretive aspect of pesticides, can be improved, especially by finding penetrants. These chemicals help the active ingredient of the pesticide to penetrate into the plant, so that the dosage of the active ingredient can be lowered.

THE ROLE OF FUNGICIDES IN INTEGRATED PEST MANAGEMENT

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Summary

The analysis of trends of pesticide use is important in relation to the evaluation of IPM projects. Unfortunately, the existing data base is insufficient to allow for a detailed analysis. The available information only allows the drawing of very general conclusions.

As far as major market trends are concerned, the global pesticide market shows negative growth rates in real terms for the past three years. This situation is largely due to saturated markets in North America and Western Europe. The major area of growth in pesticide use is in Asia. In particular, India and China are expected to have high growth rates in pesticide sales until the mid-nineties.

It was pointed out in the analysis that it is important to identify the determinants of pesticide use. Among these factors are pesticide prices, prices of input factors which are important for the use of non-chemical methods of pest control such as labour, machinery and information. Also developments in the "pest-crop-human interference complex" have to be analyzed in relation to development trends in pesticide use.

Finally, it was stressed that concerted efforts to improve the data base on pesticide use, including pesticide use by crop type (quantity and value) over a considerable period of time, are essential for making more reliable predictions on pesticide use. Also, it was made clear that the growth in pesticide use has to be analyzed in relation to the notion of a socially optimal level of pesticide use. If such an analysis is further delayed, evaluation of the impact of IPM projects will not be possible.

STATUS OF PESTICIDE RESISTANCE AND ITS MANAGEMENT

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and

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Summary

Resistance Management for Selected Weeds

The development of herbicide-resistant weed populations is influenced by chemical control practices used, including their long-term continuous use in the same fields or areas of crop use. Alternation of production practices offers the greatest promise of alleviating resistance and includes avoidance of using the same herbicide year after year, reducing specific rates under closely managed production systems, early detection of weed infestations and early treatment. Herbicides should be rotated periodically and good crop rotations encourages. Other weed management techniques should be integrated with herbicides to complement the control of particular species.

For enzyme-specific inhibition in plants by herbicides, management is best accomplished by utilizing alternative herbicides having differing modes of action. New research suggests the possibility of using mixtures of chemicals to overcome specific enzyme inhibition. For example, carbamate insecticides added to the herbicide, propanil, has significantly increased the level of control of propanil-resistant barnyardgrass.

Management of Insecticide Resistance in Major Cotton Pests

Management of insect pests is required for successful production of cotton in most of the world's production areas. For many years insecticides have played a primary role for protection of the crop against insect pests. The occurrence of insecticide-resistance in the major insect pests of cotton, such as *Heliothis* - *Heliocerverpa* bollworms, now is limiting the effectiveness of insecticides and alternative strategies have to be developed to avert serous losses of yield.

In recent years, strategies have been developed for managing insecticides to minimize losses to the cotton crop caused by insecticide-resistant pests bollworms. The goal of resistance management for these pests is to delay control failures to so late in the season that yields of cotton are assured. The strategy used at present in Australia and the USA is based primarily on restricting use of the pyrethroid insecticides to one generation of bollworms per year. The use of the pyrethroids is based on careful monitoring of the increase in resistance in the bollworm

population in cotton. The use of pyrethroids is restricted to susceptible populations. When resistance begins to increase in the population the use of the pyrethroid insecticide is discontinued. Although this strategy has allowed for the successful production of cotton in bollworm-infested areas, it is far from perfect in that some yield losses often occur and the level of pyrethroid resistance continues to increase in these pest strains.

An alternative approach being developed in Texas and already in use on a limited basis involves treatment of the cotton with low dosages of *Bacillus thuringiensis* (B.t.) when bollworms first appear in the crop. The use of B.t. at low dosages slows the rate of development of the bollworm larvae, exposing them for longer periods to predation and parasitism by their natural enemies. The low dosage also kills some of the larvae and increases susceptibility of the survivors to chemical insecticides. It also reduces the rate of feeding by diseased larvae. The use of low doses of B.t. complements and aids natural factors which cause mortality of the bollworms and which often are able to hold the numbers of the pests below yield-damaging levels. In this system, a bollworm ovicide may be added to the B.t. when egg counts become high. Also, more toxic insecticides, such as the pyrethroids, may be used on a restricted basis at an appropriate time to reduce high numbers of pests to below damaging densities. The basis for this strategy is to maintain and increase the effectiveness of the natural control system and not to replace it with toxic chemicals.

As the level of insecticide-resistance increases in cotton insect pests, with the concomitant decrease in the effectiveness of available insecticides, future IPM programmes for cotton will have to place less reliance on insecticides and more on natural mortality factors.

USE OF TRANSGENIC PLANTS IN IPM

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Summary

Biotechnology offers the potential to advance significantly host plant-resistance breeding. By accessing genes previously unavailable to plant breeders, biotechnology can produce plants with important new disease resistance and herbicide-tolerance characteristics. Among the first products from this technology are insect-resistant plants.

Initial products will be based primarily on coding for the insecticidal proteins from *Bacillus thuringiensis*. This microbe is the source of genes coding for highly efficacious proteins specific for certain insects. Cotton with lepidopteran (heliothines) control, potatoes with coleopteran (Colorado potato beetle) control, and corn with lepidopteran (European corn borer) control are all in advanced stages of development. In field trials, all have exhibited significant control of targeted insects. These products, once commercialized, have the potential to reduce significantly chemical insecticide use in the affected crops. Transgenic plants also offer targeted insect control so beneficial insects can be maintained. These improved plants should fit well into IPM systems.

Despite the tremendous potential of these improvements, transgenic plants are not a cure-all to crop protection. Thoughtful incorporation into IPM systems will be required. Two issues will need special attention. New practices will be needed to manage the entire pest complex once broad-spectrum insecticide use is reduced. Resistance management strategies will also be needed to ensure a long, useful life for transgenic plants.

Initial introductions for transgenic plans will focus on world areas where investment costs can be recouped by those developing these products. Growers in those areas generally have the knowledge and support structure to properly integrate transgenic plants into their production systems. Much greater effort will be required to introduce plants into other world areas in order to realize their full potential.

BIOLOGICAL PESTICIDES AND GENETICALLY-ENGINEERED MICRO-ORGANISMS IN IPM PROGRAMMES

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Summary

([1]) Biological Pesticides: Some Technical and Social Issues

There is a wide variety of pathogens and micro-organisms available for use in pest management. These include fungi, nematodes, bacteria, viruses and microsporidians. However, these constitute around 1-2% of usage compared to commercially available chemical pesticides. It is sometimes predicted that their usage will remain a minority, perhaps not exceeding 5% in the longer term. The authors were concerned to identify technical and non-technical issues that would lead to maximum usage of biological pesticides as components of IPM programmes.

The authors recognised that the species and strains of micro-organism in current use or being developed represent a minute fraction of the relevant genetic and species biodiversity waiting to be explored. It was also recognised that conventional or traditional techniques of pathology and genetics should continue to play a major role in development of practical biological pesticide options. Technical areas where continued development is required include: mass production technologies (ranging from cottage industries to hi-tech fermentation), storage (shelf life, etc.), packaging, formulation, and technology of application.

The authors also recognise that recombinant-DNA technologies represent powerful tools for genetic manipulation of microbials, especially viruses and bacteria to enhance virulence and speed of action. These activities should assist in identifying genes suitable for use in transformation of crop plants to broaden the choice of host plant resistance mechanisms beyond the widely used Bt genes in plant transformation.

Max Whitten drew attention to several factors which have emerged in the development of biotechnology options which could threaten empowerment of farmers and those who are supposed to benefit from development of these options. Personal ambition by individual scientists, institutional and even national prestige to be first to develop a transgenic plant or micro-organism and have it commercially available, is a more conspicuous feature of biotechnology research than it has been in development of chemical pesticides. A belief exists amongst some laboratory-based molecular biologists that they have both the knowledge to define the problem and develop the solution in relative isolation of field biologists, social scientists, extension officers and farmers who are closer to the problem. This science/technology driven perspective has led to distortions in the research effort and has created unrealistic expectations amongst some farmer groups. Biotechnology represents a

powerful set of tools, but these must be deployed in conjunction with those better placed to define the problem and evaluate the solution.

Furthermore, publicly funded R & D organizations, when facing a choice between developing two options, only one of which might develop an income stream for their organization, might be inclined to pursue the income-generating option. Thus, in circumstances of shrinking resources, genetically engineered plants or micro-organisms could be a preferred option to a biological control or cultural option which did not generate revenue streams for the organization. In other words, just as with the chemical industry, publicly-funded research organizations need not necessarily be acting in the pubic interest or working towards grower empowerment. It is prudent to recognize the legitimate or "understandable" agendas of players in biotechnology R & D. Pesticide manufacturers are not the only group with interests that could lead to dis-empowerment of farmers.

Another factor requiring consideration is that the majority of governments provide direct or indirect subsidies that favour chemical pesticides over biological pesticides. In many cases, the direct and identifiable costs of biological pesticides may be higher than with chemical pesticides, but the negative alternatives on health and the environment would be much lower. Such government actions lead to excessive use of chemical pesticides, in the sense that their usage is not socially or economically optimal. In other words, there is an important role for economic policy of governments in ensuring effective development of IPM programmes with commitments emerging for signatories to the UNCED Treaty of Rio de Janeiro.

([2]) Considerations on the Use of Biological Pesticides in IPM in Developing Countries

Biological pesticides can be used in IPM in other ways than the insecticidal approach (innundative releases). The introduction/ colonization and the inoculative releases approaches may be more desirable ways of using pathogens to control pests under certain conditions and cropping systems. Moscardi cited the example of the use of a baculovirus to control the rhinoceros beetle, a major pest of coconuts in Southeast Asia. Purified inocula of the virus are used to contaminate adults of the pest, which are released in highly infested areas. The infected adults spread the disease among other beetles, provoking an increase of virus occurrence in the pest population. The fungus *Metarhizium anisopliae* is also used to complement the action of the virus, by means of contamination of breeding places of the beetle. As a result, pest populations can be reduced at practically no cost to the coconut farmers.

The use of the nuclear polyhedrsis virus (NPV) of *Anticarsia gemmatalis* (Lep. Noctuidae) in soybeans in Brazil is today the most significant case of an insect virus employment as a microbial pesticide. This virus is applied in ca. 1.0 million ha annually in Brazil (about 10% of soybean area). The main reasons for the success of this programme were pointed out as follows: a) possibility of virus production under field conditions; b) cost of virus commercial formulation lower than that of chemicals; c) high compensation of soybean to defoliation up to

flowering (30-40%); d) no simultaneous occurrence of other important pests; e) development of proper technology transfer methods - pilot areas were implemented involving extensionists and farmers since the beginning. In spite of the characteristics of each pathogen-host-crop system, the successful use of viruses and other pathogens is a matter of adequate research and development as well as of the strategies adopted for technology transfer, taking into account the relatively slow speed of kill and the narrow host spectrum of these agents.

Biotechnological approaches towards enhancing the insecticidal properties of baculoviruses have been developed. Several types of foreign pesticidal genes have been proposed for insertion into viral genomes aiming at increasing the speed of kill of viruses, including: insect-specific toxins, hormones, hormone receptors, metabolic enzymes, and growth regulators. However, within a short timeframe, especially for developing countries, most significant improvements of biological pesticides will probably not result from biotechnological techniques, but rather from improved mass production, quality control and formulation procedures, selection of more virulent strains from the natural genetic pool, as well as through a better understanding of the factors limiting their epizootiology and usefulness as biological pesticides. Most relevant contributions of biotechnology will probably first occur in the areas of characterization, quality control and environmental monitoring of biological insecticides.

The perspectives and practical value of biotechnological methods to IPM programmes are difficult to assess at the present, since developments in this field are quite recent and are not available in most developing countries. As they are made available, these technologies should be carefully evaluated for their usefulness and possible environmental impacts, before they are definitely incorporated into IPM programmes.

([3]) Biological Pesticides in Integrated Pest Management Programmes: The Colombian Example

Based mostly on *Trichogramma* spp. and microbial agents (*Beauveria bassiana*, *Bacillus thuringiensis*, *Metarhizium anisopliae*) solid IPM programmes have been established in Colombia where lepidopterous pests are present. These programmes have reduced the number of insecticide sprays per crop cycle, re-establishing biological control equilibrium in the agro-ecosystem favouring a revival of the activity of indigenous natural enemies, and leading to a clean environment and sustainability.

Biological pesticides currently are used for the control of more than 10 pests on major crops (cotton, tomato, soybean, cassava, sugarcane, corn, sorghum, etc.) with an average pesticide cost reduction more than 50% in most cases.

The success of biological control in Colombia is based on a joint effort of that are basic research carried out by government research centres and the private sector, assuring the commercial production of biopesticides needed are available for national demands and for exportation to other countries in America.

The adoption of biological control by farmers is estimated to be: sugarcane 100%, soybean 80%, cotton 70%, tomato 50%, cassava 50% and oil palm 40%.

Diversification of biological control agents to broaden the possibilities of continuous success when controlling a pest biologically is something that is always considered.

Positive results have been obtained when help has been offered to different countries in South America to solve similar problems studied and solved in Colombia. FAO may play an important role in promoting this kind of technology transfer where solution of pest problems in one country may be applicable to other countries.

Examples of the use of biological pesticides in South America show that small and developing countries can reduce dependency on chemical pesticides in a manner which is sustainable, economical and environmentally sound. This solution requires a commitment by the government and the research community to work with farmers providing them with knowledge and options so that a wide array of non-chemical options are incorporated into IPM programmes.

USE OF NOVEL CHEMICALS IN IPM

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Summary

Attractants, growth regulators and pheromones have been used in novel approaches to manage insects in several ways, and expectations are high that these compounds will be more widely used than ever for this purpose in the future. Deterrents, kairomones and repellents are of less importance in pest management in agriculture but offer many potential new areas of research. Examples are given of novel chemical uses, wither possible or currently in use for each of these types of chemicals.

The best example of pheromones in use for management and/or elimination of an insect is in the boll weevil. Traps (Mitchell & Hardee, 1974) baited with the pheromone, grandlure (Hardee *et al.*, 1975) are part of a large-scale programme in conjunction with judiciously-used insecticides to eradicate the boll weevil from the United States by the year 2015. At the time of this report, the boll weevil had been eliminated with these techniques from Virginia, North and South Carolina, and parts of Georgia, Florida and Alabama (W. Greffenstette, USDA-APHIS, Hyattsville, MD, pers. comm.). The remainder of these states and parts of Mississippi, Tennessee and Texas enter the first phase of this programme in 1994 or 1995, as dictated by grower referenda in early 1994. Upon its completion, this programme will have saved the USA cotton producer millions of dollars and reduced significantly the total amount of insecticide sprayed into the environment.

As future constraints on insecticide usage, such as resistance, loss of effective materials due to environmental concerns and resulting secondary pest problems, continue to increase as they undoubtedly will, so-called novel chemicals such as discussed above will increase in importance and receive greater attention from research time and dollars. Greatest emphasis should be placed on chemicals and techniques which are "environmentally-friendly" and those to which the development of resistance is least likely.

BOLL WEEVIL IN SOUTH AMERICA

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Summary

Cotton production undergirds a major business in South America. The boll weevil is one of the fiercest cotton pests on the American continent. Its introduction into Brazil in 1983 had a major impact on the stability of the cotton business in the whole region.

The boll weevil has caused many traditional growers to produce alternative crops or to leave the rural areas. Most affected were growers who produced perennial cotton in north-eastern Brazil, where the crop was important not only for the production of lint and oil, but also as forage for beef cattle at the end of each production cycle. Before the pest arrived, the area harvested to perennial cotton was 1.4 million hectares cereal to 46% of the country's harvested area. By the 1992/93 season that area was reduced to 162,000 hectares, representing only 11% of the total acreage in the country. Annual cotton production has been drastically reduced in north-eastern Brazil as well, where the boll weevil was the main factor causers an acreage reduction of 73% from the 1983/94 to the 1992/93 growing season. Its introduction into Brazil has caused a significant impact in the neighbouring countries, which have had to establish task forces to prepare the local cotton growing sector for an inevitable invasion of the pest.

Desperate Brazilian growers have adopted control measures that are effective for the control the boll weevil in annual cotton which mostly rely upon the use of insecticides. This has had considerable adverse effects on the environment. New basic and applied research should be conducted in Brazil to develop new control strategies which support the adoption of a fully integrated system of management of the pest. Important neighbouring cotton producers in South America should focus on preventing the dispersal of the weevil and to prepare growers for its eventual introduction.

WHITEFLY IN THE NEAR EAST

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Summary

Results from surveys on the pest status of the whitefly *Bemisia tabaci* showed that this whitefly is an important pest of vegetables and cucurbits in the Near East and especially under protected cultivation on tomato, cucumber and beans and, in certain countries on eggplant and sweet pepper. Attack by *B. tabaci* on tobacco is reported from Cyprus, on potato from Cyprus, Egypt and Saudi Arabia and on cotton from Egypt, Iraq, Pakistan, Sudan, Syria and Turkey. Damage to ornamentals is reported from Bahrain, Cyprus, Iran and Lebanon, and on soybean from Turkey. Most countries consider the pest to be increasing in importance. Damage is caused by direct feeding, by soiling plants with honey dew and by transmission of viral diseases.

Most whitefly-transmitted viruses belong to the Geminiviridae. They are transmitted in a persistent-circulative mode, e.g. once an adult whitely feeding on an infected plant has acquired the virus and has become infected, it can retain the virus for long periods of time and transmit it to healthy plants in the course of subsequent feedings.

The most common virus is the Tomato Yellow Leaf Curl Virus, that inflicts great damage on tomato all over the Near East.

Cotton Leaf Curl Virus was a major problem in the Sudan but was dealt with successfully through cultural practices and the use of resistant varieties. Currently this virus is spreading rapidly in Pakistan. Other viruses in particular attack watermelon but their identity and status are not well known.

Control of *B. tabaci* is largely based on the use of insecticides. The effectiveness of chemical control is decreasing due to development of resistance. Pest resurgence after treatment is common due to the depletion of natural enemies by broad-spectrum insecticides. However, in a number of countries a start has been made on testing and introducing non-chemical options and strategies such as elimination of alternate hosts, the introduction of a closed season, the use of virus-free transplants, the use of insect-proof netting, inter-cropping, more appropriate planting dates, the use of yellow stick traps, host plant resistance and the preservation of natural enemies.

The use of more selective insecticides in such a way that natural enemies are preserved is a very important strategy in *Bemisia* control.

Notwithstanding these positive developments in the use of integrated control strategies are more an exception than the rule. In most countries control of *Bemisia* is based on frequent applications of insecticides. The experience from certain Near East countries and from other parts of the world shows that this inevitably leads to the collapse of production.

It is evident that integrated whitefly management is a "must" that requires scientific competence and effective strategies that need to be developed in close collaboration with the farmers. Governments are often supportive of cotton production and, wherever serious pest situations occur, corrective measures are eventually taken. Generally no such concern is shown for vegetables and solutions are left in the hands of the pesticide dealers. This allows situations to deteriorate catastrophically resulting not only in serous economic losses but also in posing a threat to public health and the environment.

SWEETPOTATO WHITEFLY (= SILVERLEAF WHITEFLY): THE FIVE-YEAR NATIONAL RESEARCH AND ACTION PLAN -- CURRENT STATUS AND RESEARCH PROGRESS

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Summary

The sweetpotato whitefly (SPW), *Bemisia tabaci* Gennadius, increased in importance during the early 1980s in cotton production systems in Arizona and California, as well as in cultivated vegetable crops. The SPW is not new to south-western desert cotton production systems, although increasing evidence suggested a different strain, biotype or even the occurrence of a new species beginning about 1989. A new species, *B. argentifolii* sp., with the suggested common name of silverleaf whitefly (SLW) was described by University of California scientists.

The devastating impact of the SLW on the agricultural communities involved in California, Arizona, Texas and Florida identified the need for a cooperative national effort to provide solutions to the problem. A coordinated effort was made beginning in late 1991 and early 1992 to formulate a five-year National Research and Action Plan for Development of Management and Control Methodology for the Sweetpotato Whitefly (SPW), *Bemisia tabaci* (Gennadius) (USDA, 1992). Representatives of USDA agencies (ARS, APHIS, CSRS and CES), State Agricultural Experiment Stations and the commodity industries participated in meetings at Atlanta, GA, Reno, NV, and Houston, TX, providing input and expertise in identifying research, education and action programme priorities. The 1994 report of progress review acknowledged the new species' designation.

The five-year national plan provides the framework to optimize research progress and maximize return on available resources. Cooperative, complementary research programmes, open lies of communication, frequent information exchange and optimum utilization of resources were stressed as the corner-stones of the national programme. Six high priority areas for coordinated research, development and action were identified: (1) Ecology, population dynamics and dispersal; (2) Fundamental research - Behaviour, Biochemistry, Biotypes, Morphology, Physiology, Systematics, Virus Diseases, and Virus Vector Interactions; (3) Chemical Control; (4) Biological Control; (5) Crop Management Systems and Host Plant Resistance; and (6) Integrated Techniques, Approaches and Philosophies. An extremely important part of the plan was the provision of an annual review of progress. The objectives of the annual review process were to (1) provide a forum for exchange of research information and ideas, (2) plan cooperative work, and (3) evaluate research progress in relation to goals, objectives and priorities. The review process also concerns identification of areas where research is lacking and provide the framework for recommendations for (1) reassigning or deleting existing priorities, (2) adding additional priorities, (3) making other adjustments in the plan that may be necessary to accommodate the research

effort within the constraints of available resources, and (4) planning the most efficient and productive use of additional funds that may become available.

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